



September 12, 1992

Full Surface Testing of Grazing Incidence Mirrors

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(516) 584-5540

Eighth and Final Quarter Report: Introductory Outline**FULL-SURFACE INTERFEROMETRIC SCANNER**

In the present report, we present the work done during the period of August 12 to September, 1992.

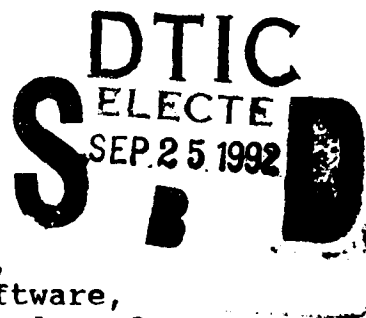
The work includes the implementation of the final testing program for the FSIS prototype system using the latest software package. It also included work on the final report.

The custom T.W.O. cylindrical mirror was used for testing. The scan is made of 5 subapertures, two inches each with one inch overlap area between subapertures.

The project goals for the eight quarters (entire contract) have been achieved. These include:

1. Prototype design,
2. Procurement and testing of components,
3. Mathematics and algorithm development,
4. Interferograms and data reduction algorithms,
5. Construction of first prototype,
6. Automated operation software development,
7. Construction and evaluation of modified prototype,
8. Integration of automated hardware controls and software,
9. Testing full surface interferometer/ aspheric optical surfaces,
10. Initiation of user manual and documentation,
11. Additional testing and modification,
12. Software refinement and development,
13. Completion of the users manual and documentation,
14. Report for the eighth and final quarter, and
15. Final project report.

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Contract # N00014-90-C-0246



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The measurement is now fully automated and operates as follows:

- The interferograms of the five subapertures are captured by scanning the mirror with the NEAT long travel stage under computer control
- Next, the interferograms are computed individually and merged into a single surface using first order least square fitting over the overlap areas.

This yields a series of slope function profiles or traces of the reflected wavefront in the direction of the long side of the mirror

- Finally, the slope profiles are numerically integrated in the same direction.

This yields a series of profiles or traces of the reflected wavefront in the direction of the long side of the mirror.

The computer outputs include:

1. A 3-D isometric plot representing a stack of the multiple traces of wavefront slope function
2. A 3-D isometric plot representing a stack of the corresponding multiple traces of the wavefront function.

In each case, a single trace of the wavefront slope or the wavefront itself can be extracted and displayed interactively by key in.

Along with the individual trace, the computation yields values for

- The root-mean-square (RMS) deviation
- The peak-to-valley (P-V) deviation.

In the following we show the computer plots (36 plots) for the wavefront slope and wavefront corresponding to a typical measurement.

CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / SLOPE FUNCTION

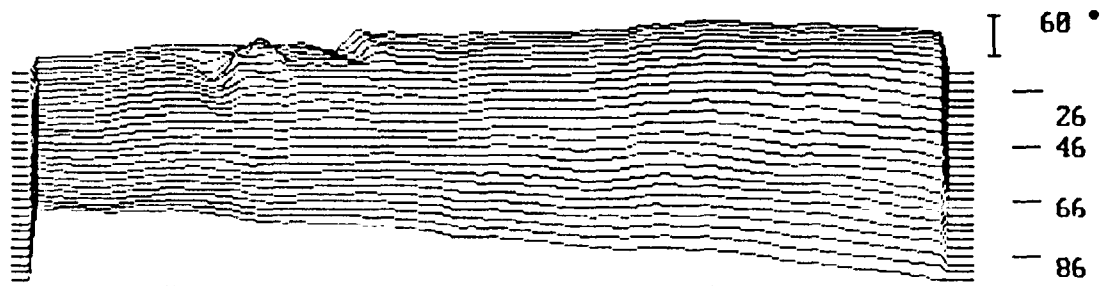


12 °/ LEVEL
RMS 17.25986
P-V 112.5427

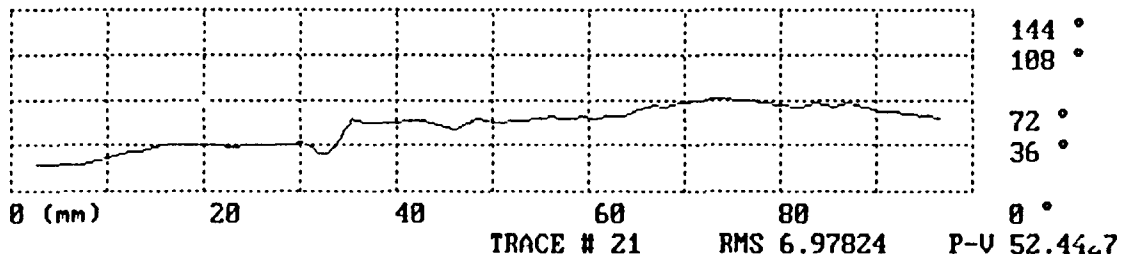
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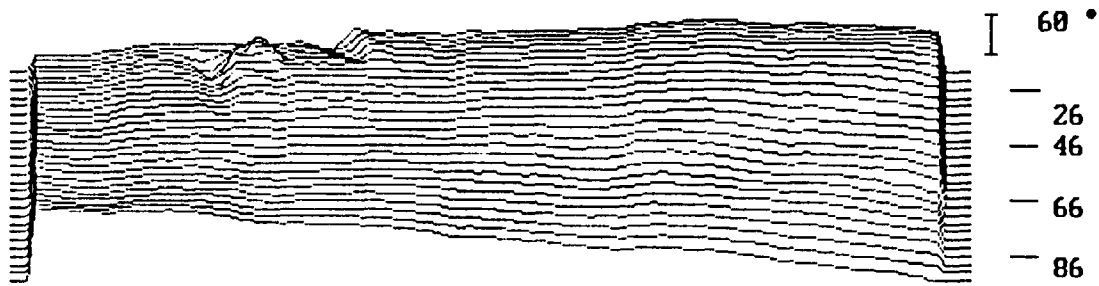
CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / SLOPE FUNCTION



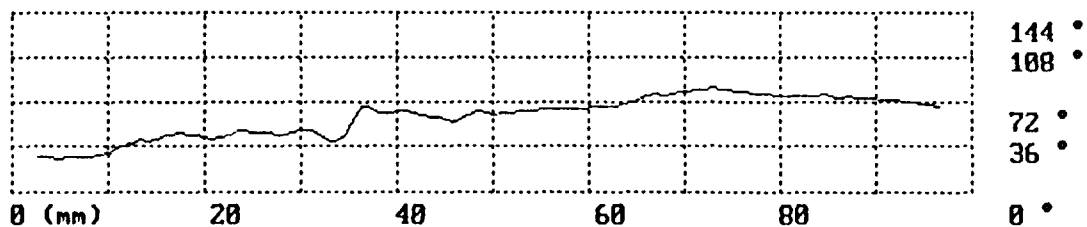
RMS 17.25986 P-V 112.5427



CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / SLOPE FUNCTION



RMS 17.25986 P-V 112.5427

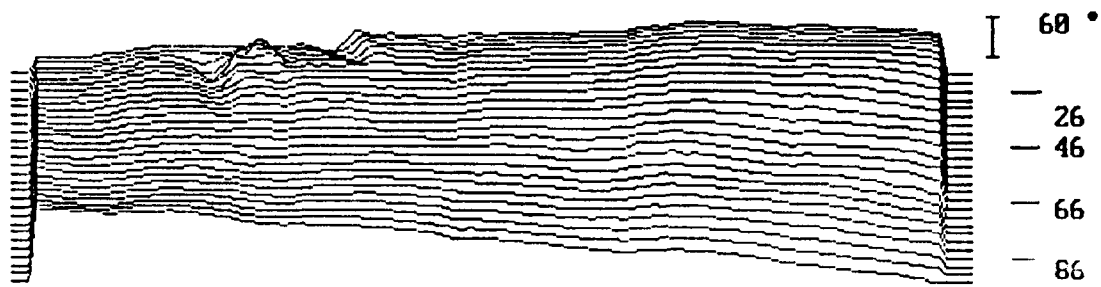


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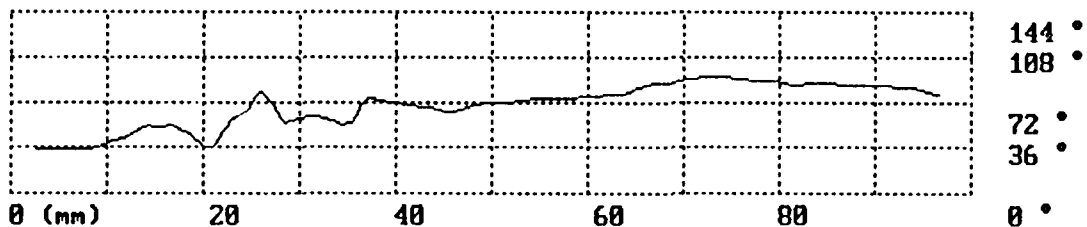
RMS 21.84303

P-V 55.91151

CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / SLOPE FUNCTION



RMS 17.25986 P-V 112.5427



0 (mm)

20

40

60

80

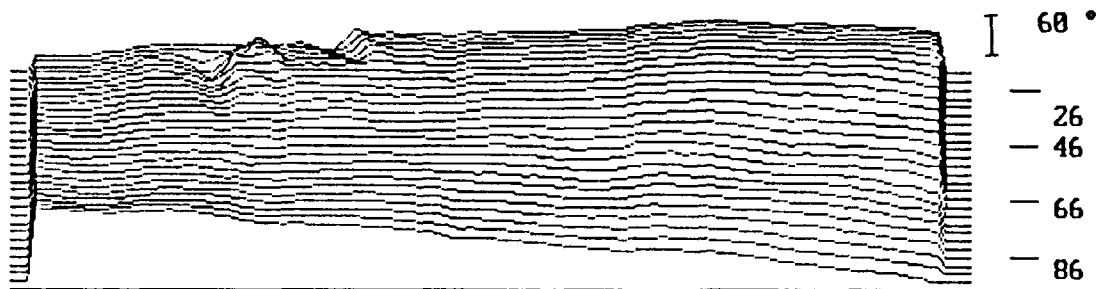
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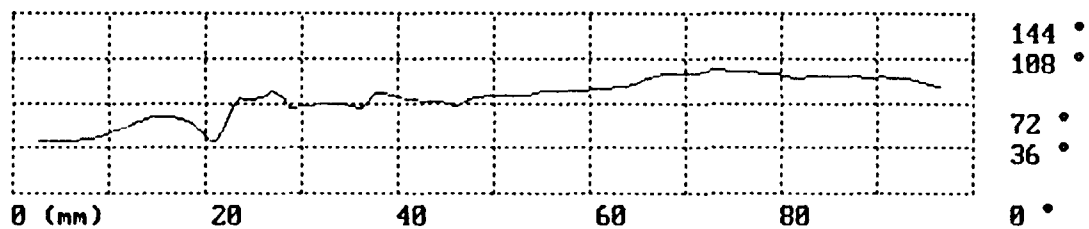
RMS 12.76636

P-V 58.73429

CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / SLOPE FUNCTION



RMS 17.25986 P-V 112.5427



θ (mm)

20

40

60

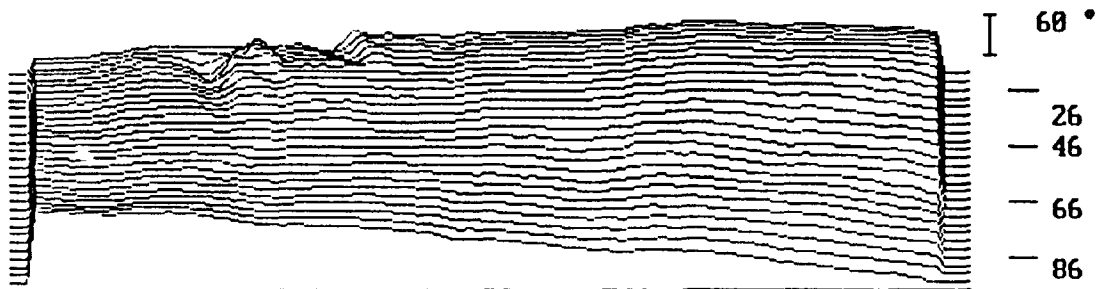
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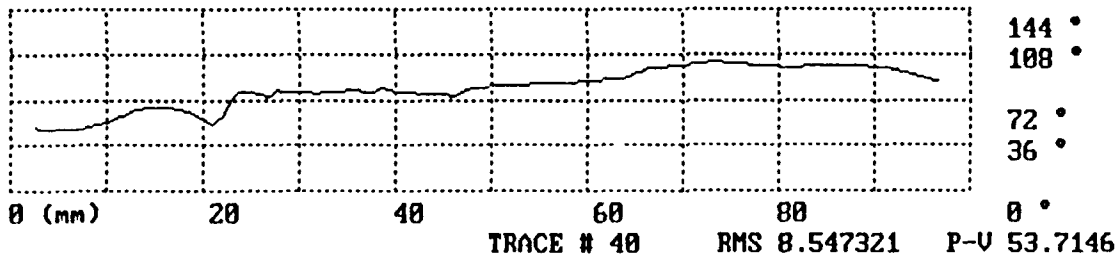
RMS 9.761338

P-V 57.60325

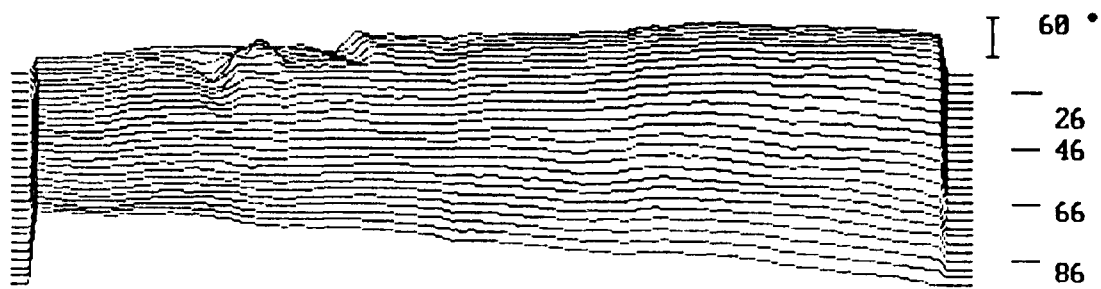
CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / SLOPE FUNCTION



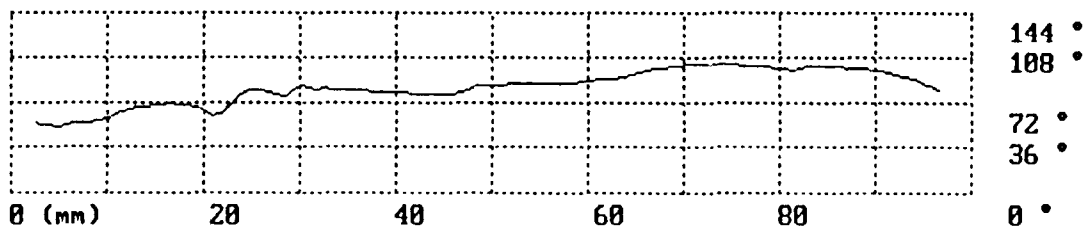
RMS 17.25986 P-V 112.5427



CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / SLOPE FUNCTION

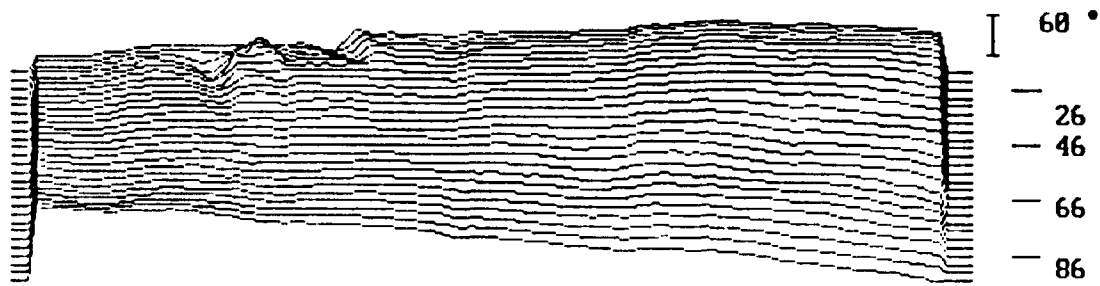


RMS 17.25986 P-V 112.5427

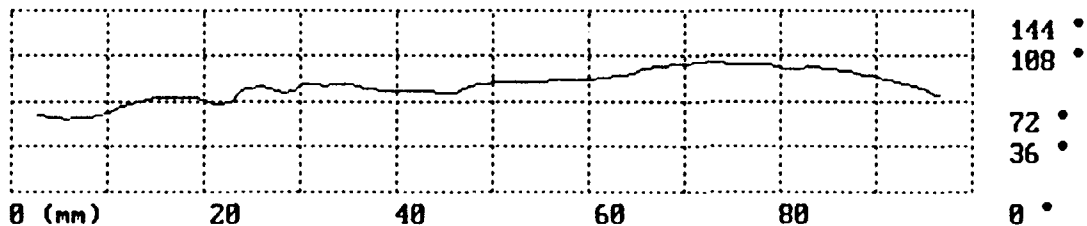


TRACE # 45 RMS 7.553936 P-V 50.37174

CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / SLOPE FUNCTION



RMS 17.25986 P-V 112.5427



0 (mm)

20

40

60

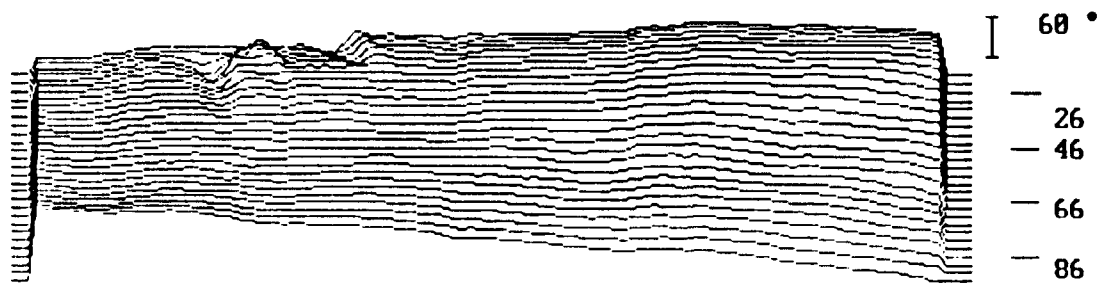
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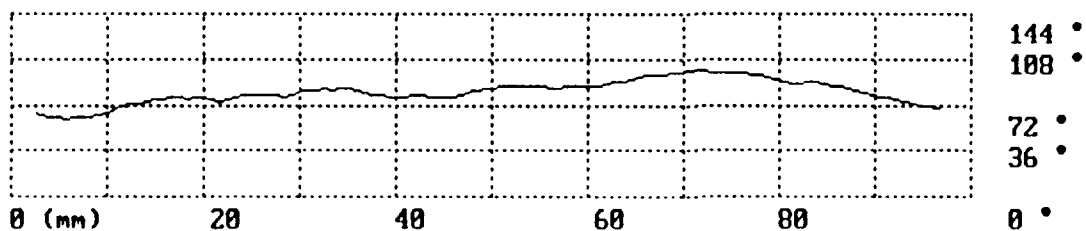
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P-V 44.41621

CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / SLOPE FUNCTION



RMS 17.25986 P-V 112.5427

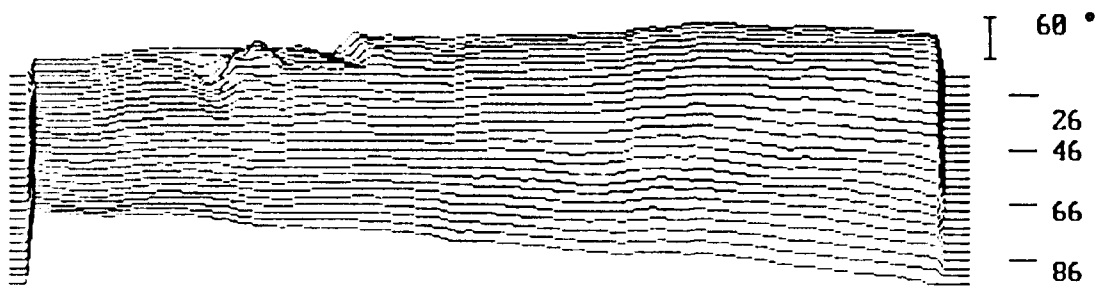


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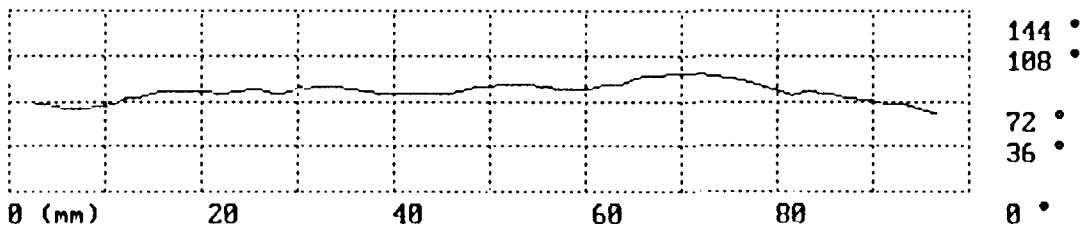
RMS 4.622995

P-V 37.36874

CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / SLOPE FUNCTION



RMS 17.25986 P-V 112.5427



0 (mm)

20

40

60

80

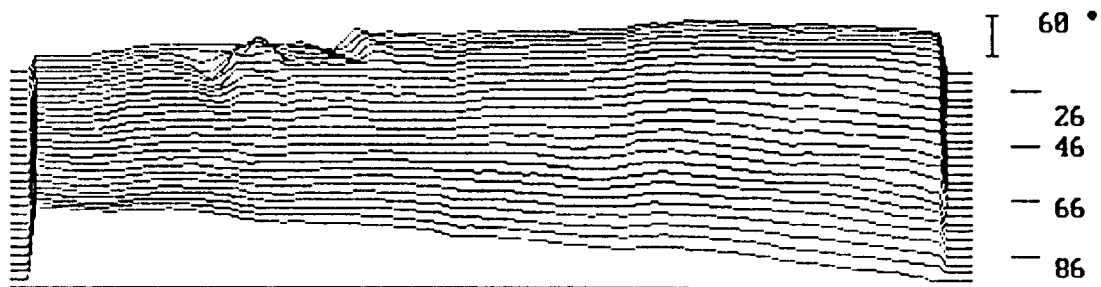
0 °

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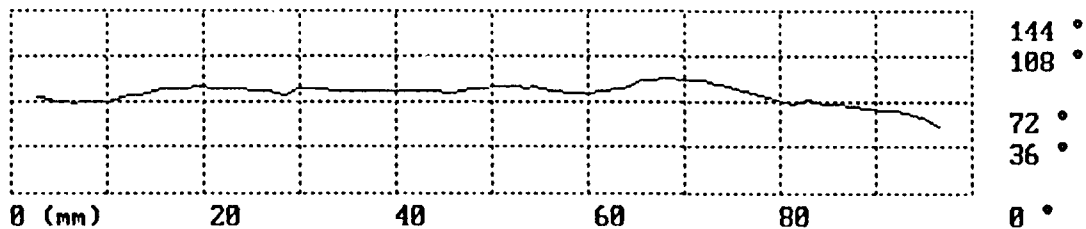
RMS 3.246115

P-V 31.79525

CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / SLOPE FUNCTION



RMS 17.25986 P-V 112.5427

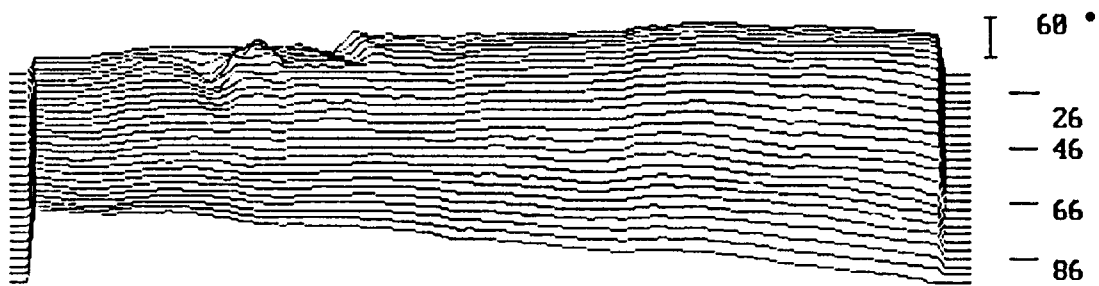


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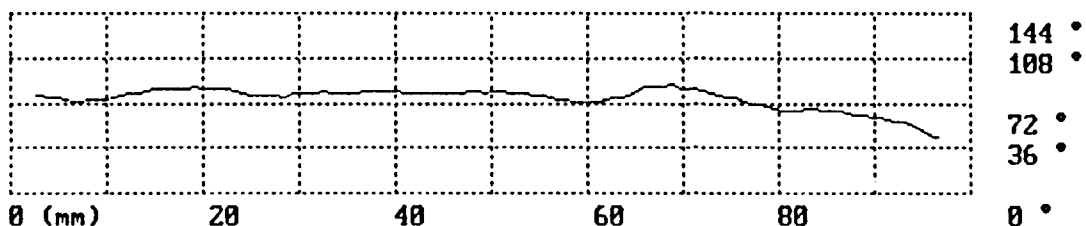
RMS 2.661066

P-V 37.34784

CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / SLOPE FUNCTION



RMS 17.25986 P-V 112.5427



0 (mm)

20

40

60

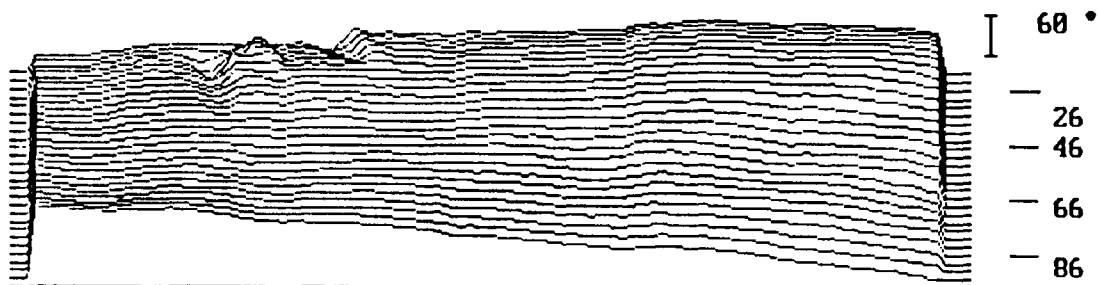
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TRACE # 70

RMS 2.678192

P-V 41.50981

CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / SLOPE FUNCTION

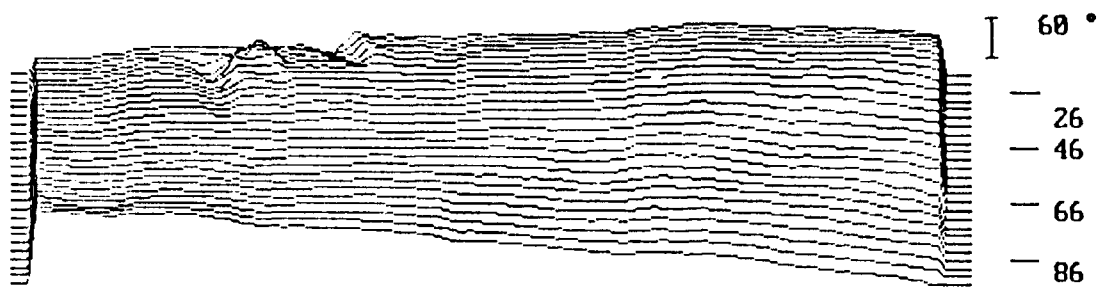


RMS 17.25986 P-V 112.5427

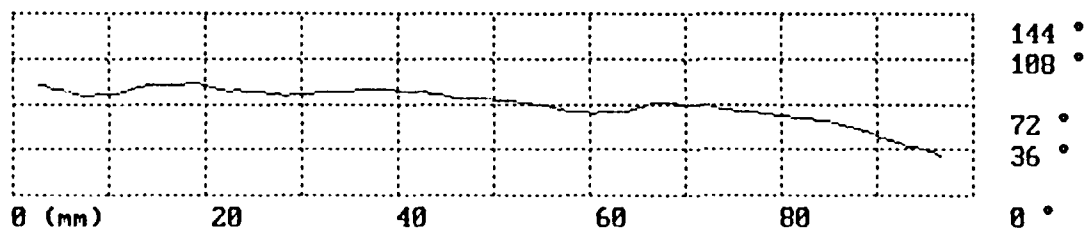


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CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / SLOPE FUNCTION

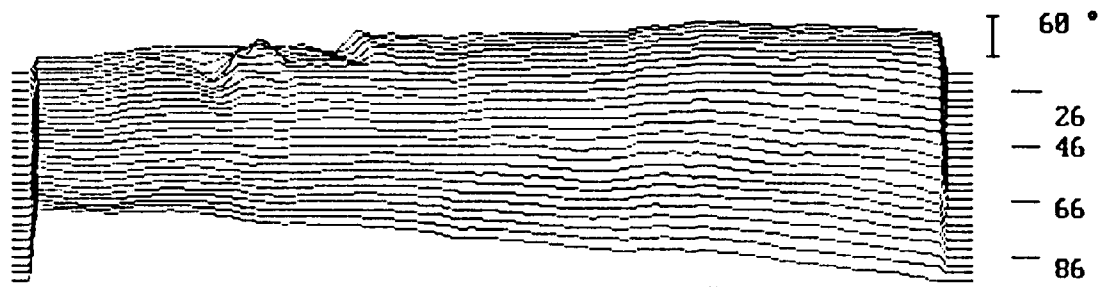


RMS 17.25986 P-V 112.5427

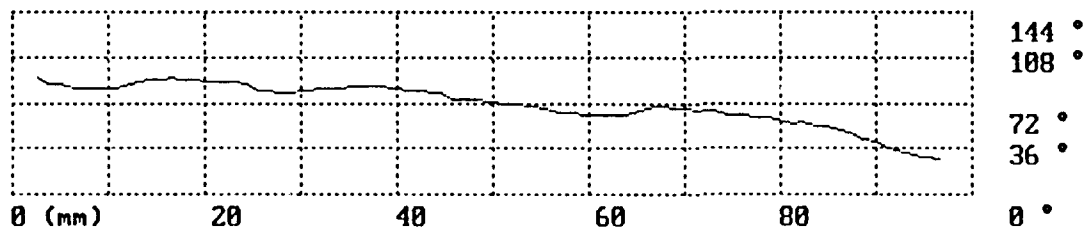


TRACE # 80 RMS 3.83541 P-V 57.69175

CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / SLOPE FUNCTION



RMS 17.25986 P-V 112.5427

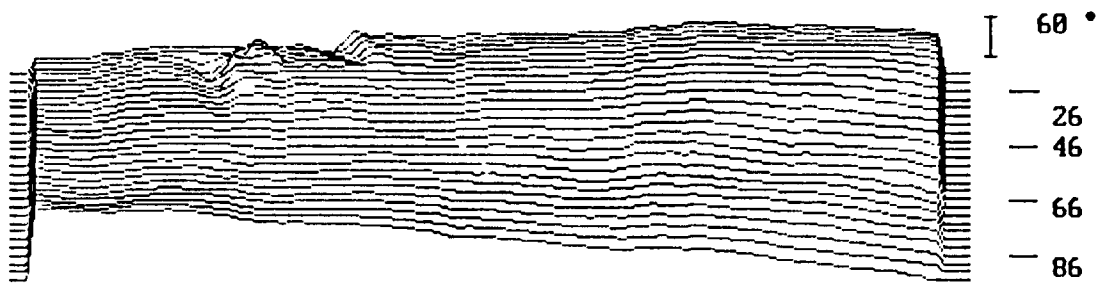


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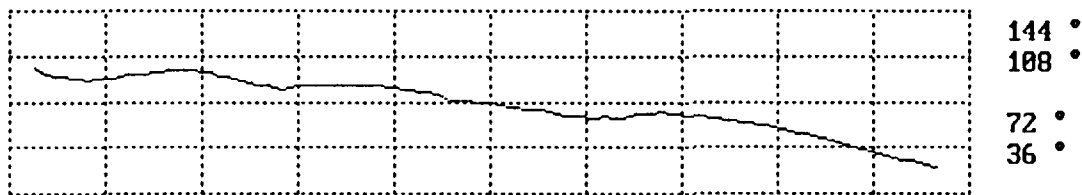
RMS 4.573123

P-V 64.41351

CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / SLOPE FUNCTION



RMS 17.25986 P-V 112.5427



0 (mm)

20

40

60

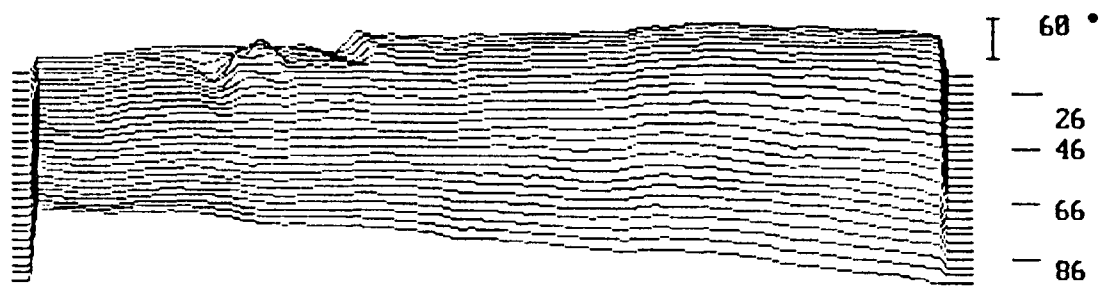
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TRACE # 90

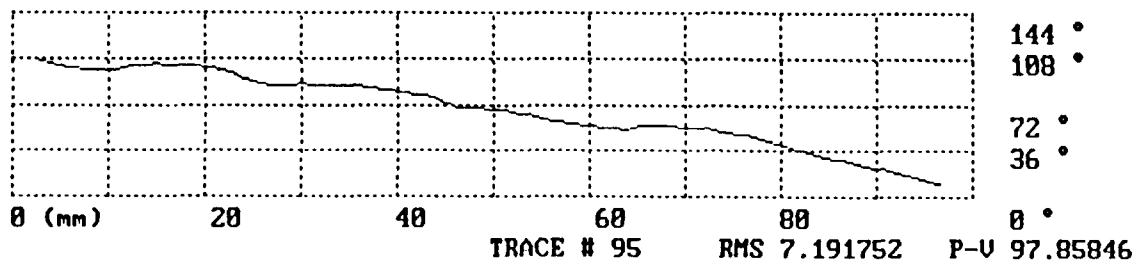
RMS 5.676682

P-V 78.65374

CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / SLOPE FUNCTION

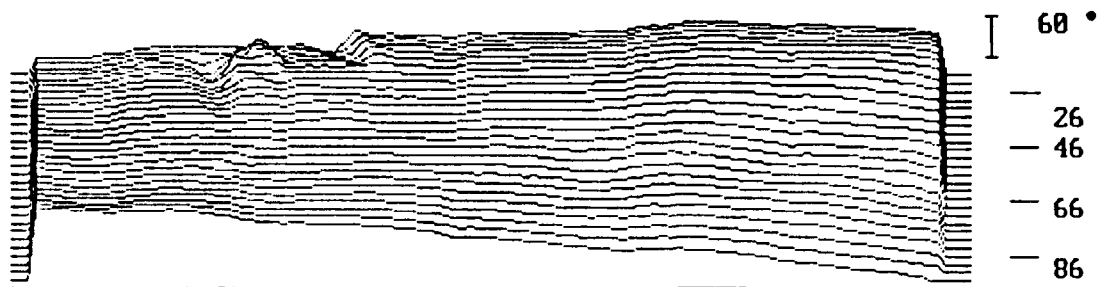


RMS 17.25986 P-V 112.5427

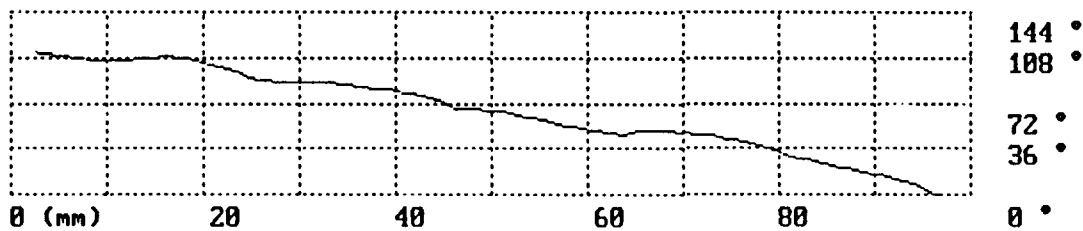


TRACE # 95 RMS 7.191752 P-V 97.85846

CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / SLOPE FUNCTION



RMS 17.25986 P-V 112.5427

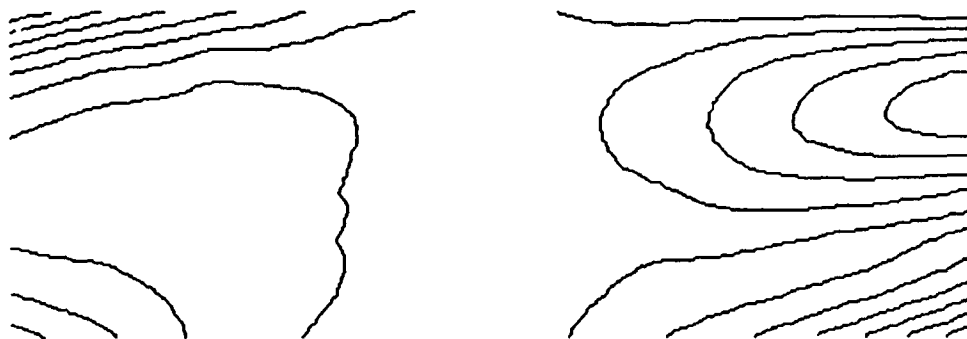


TRACE # 98

RMS 7.928579

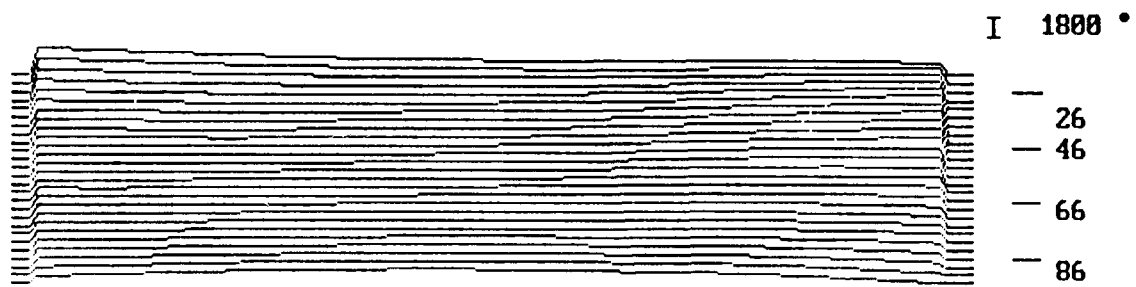
P-V 112.5427

CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / WAVEFRONT FUNCTION

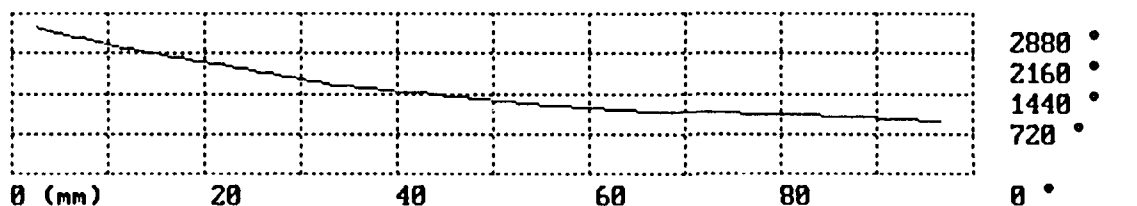


180 °/ LEVEL
RMS 275.4231
P-V 2648.377

CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / WAVEFRONT FUNCTION



RMS 275.4231 P-V 2648.377

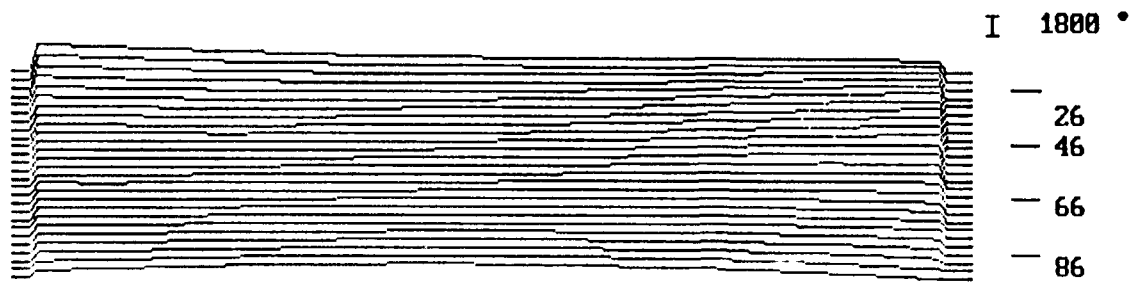


TRACE # 21

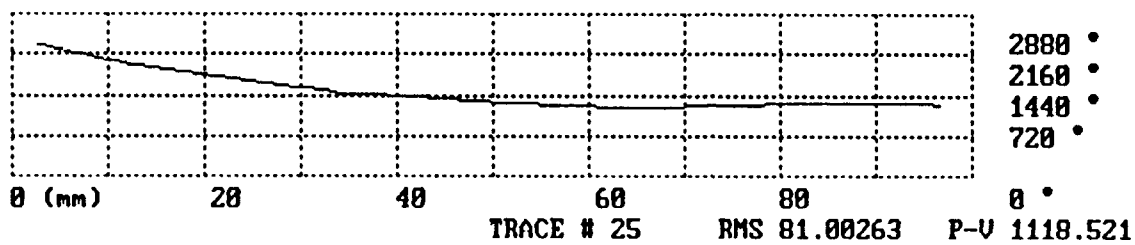
RMS 119.4098

P-V 1705.787

CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / WAVEFRONT FUNCTION

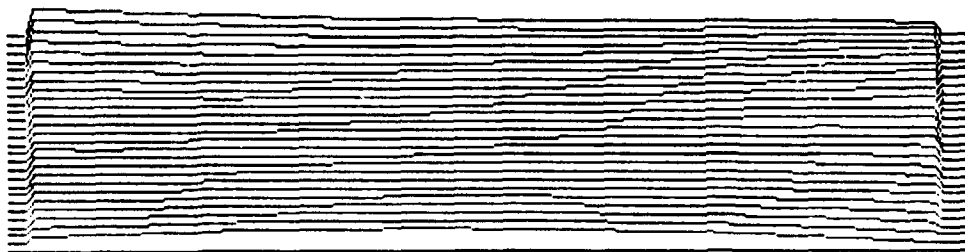


RMS 275.4231 P-V 2648.377



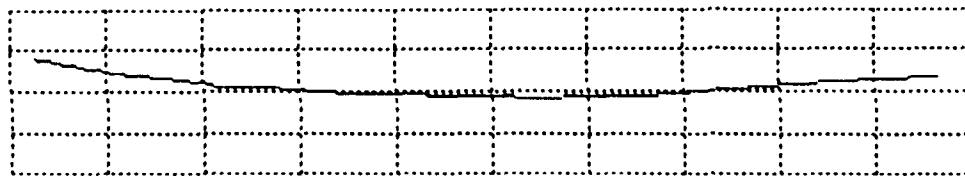
CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / WAVEFRONT FUNCTION

I 1800 °



— 26
— 46
— 66
— 86

RMS 275.4231 P-V 2648.377



2880 °
2160 °
1440 °
720 °

θ (mm)

20

40

60

80

0 °

TRACE # 30

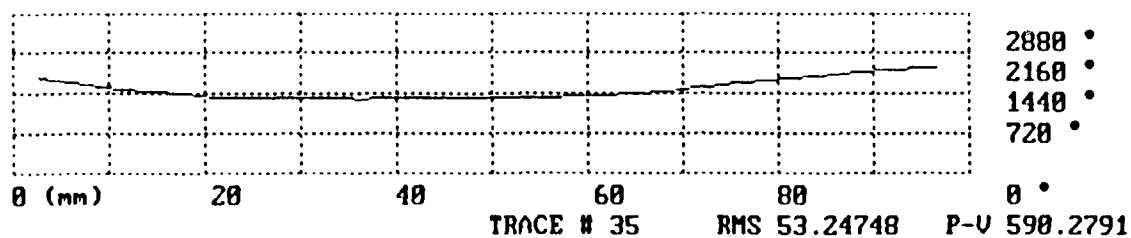
RMS 54.41294

P-V 690.6887

CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / WAVEFRONT FUNCTION

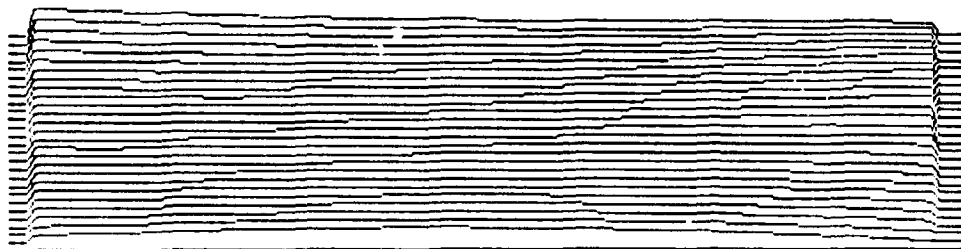


RMS 275.4231 P-V 2648.377



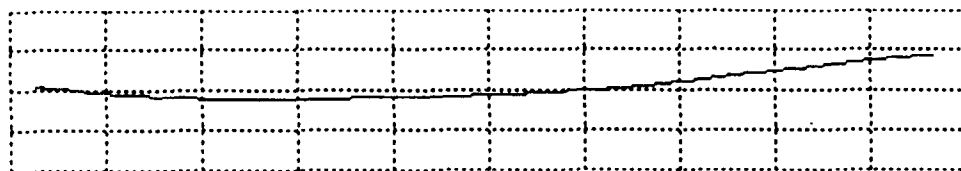
CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / WAVEFRONT FUNCTION

I 1800 °



— 26
— 46
— 66
— 86

RMS 275.4231 P-V 2648.377



2880 °
2160 °
1440 °
720 °

Ø (mm)

20

40

60

80

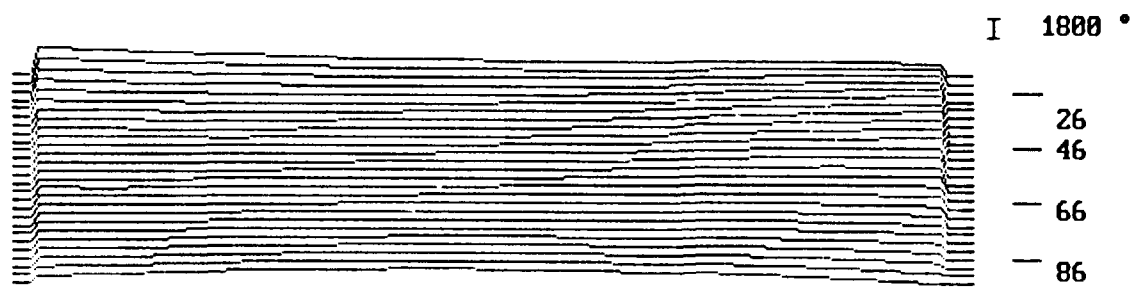
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TRACE # 40

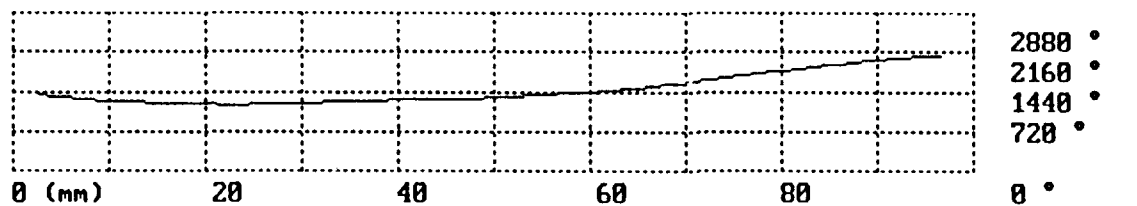
RMS 61.87016

P-V 816.8084

CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / WAVEFRONT FUNCTION



RMS 275.4231 P-V 2648.377

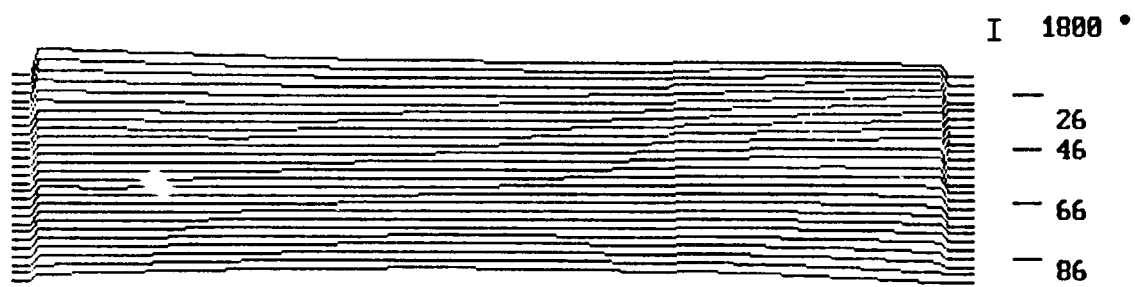


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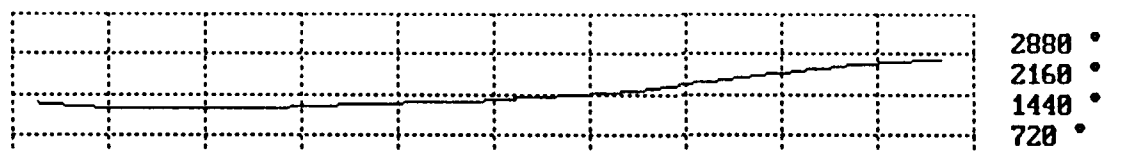
RMS 66.12693

P-V 986.5993

CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / WAVEFRONT FUNCTION



RMS 275.4231 P-V 2648.377



0 (mm)

20

40

60

80

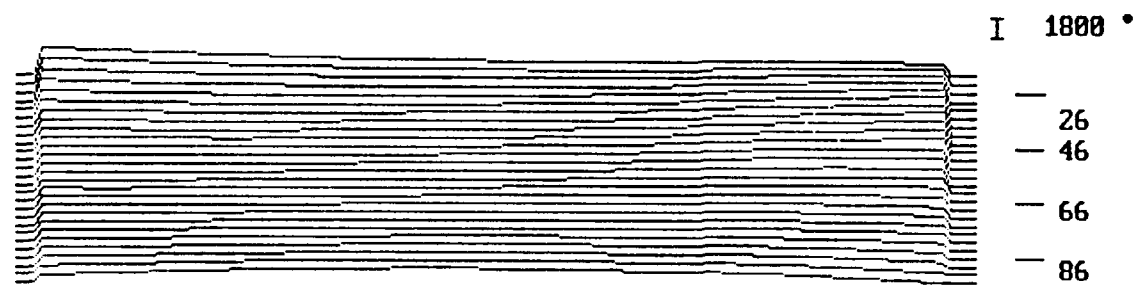
0 °

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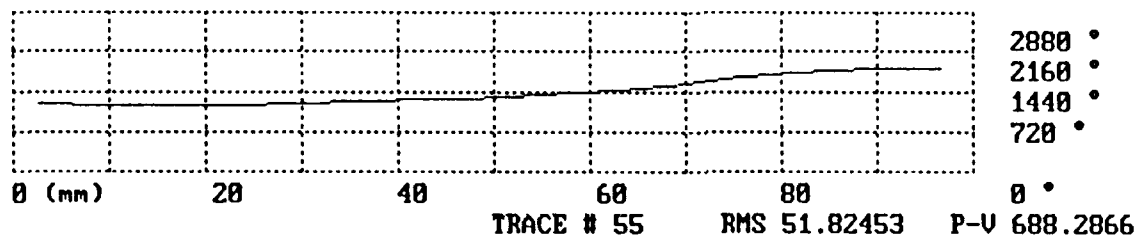
RMS 64.26296

P-V 873.4325

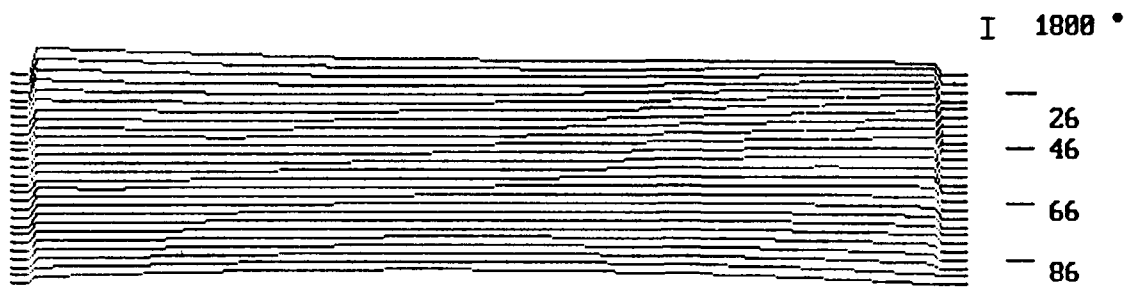
CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / WAVEFRONT FUNCTION



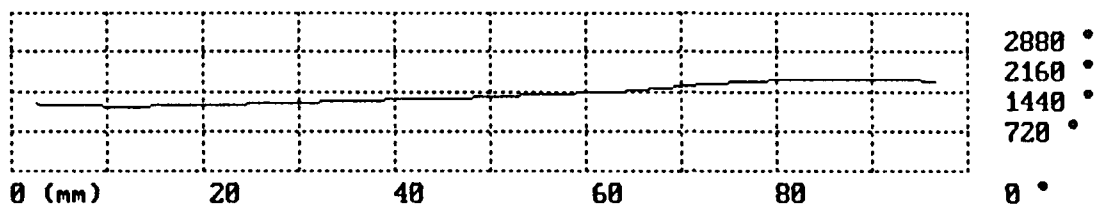
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CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / WAVEFRONT FUNCTION



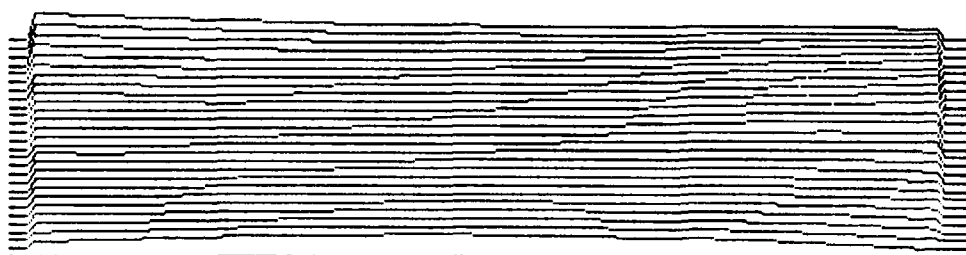
RMS 275.4231 P-V 2648.377



TRACE # 60 RMS 36.91392 P-V 507.2185

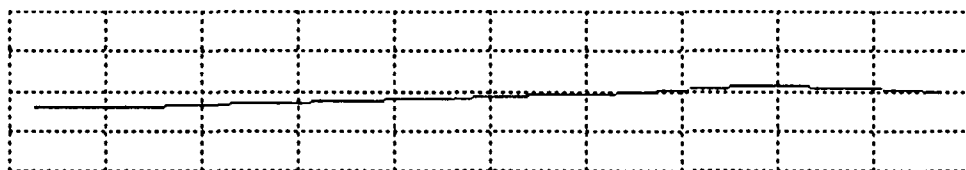
CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / WAVEFRONT FUNCTION

I 1800 °



— 26
— 46
— 66
— 86

RMS 275.4231 P-V 2648.377



2880 •
2160 •
1440 •
720 •

r (mm)

20

40

60

80

0 •

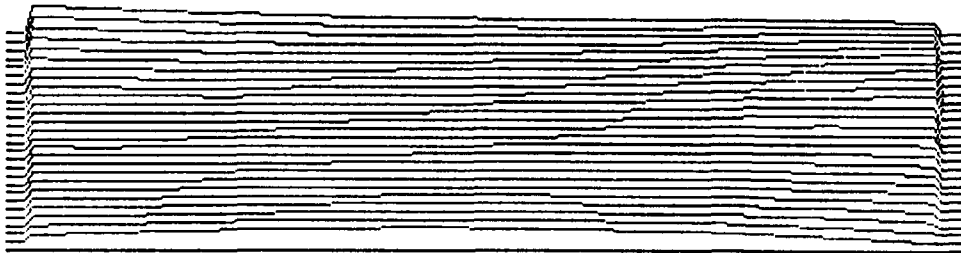
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RMS 25.14735

P-V 387.2314

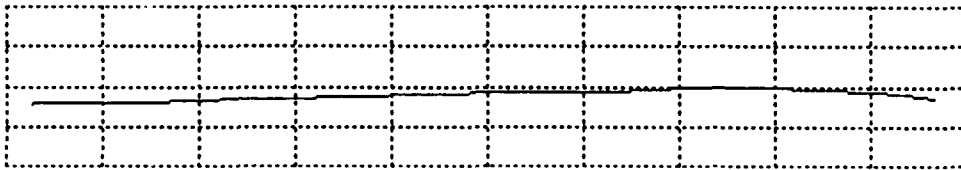
CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / WAVEFRONT FUNCTION

I 1800 °



— 26
— 46
— 66
— 86

RMS 275.4231 P-V 2648.377



2880 °
2160 °
1440 °
720 °

θ (mm)

20

40

60

80

0 °

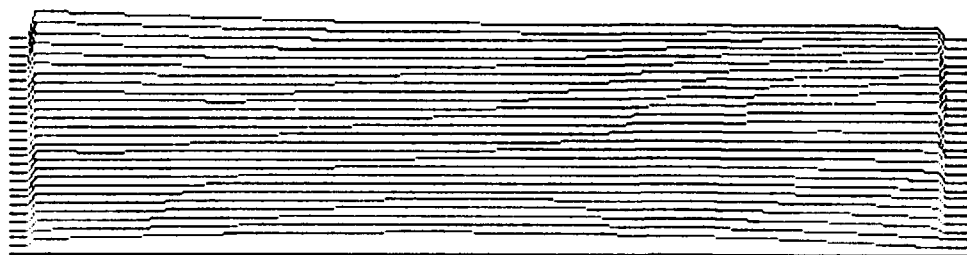
TRACE # 70

RMS 19.33507

P-V 306.4107

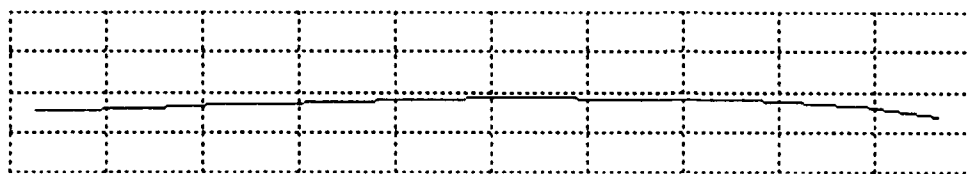
CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / WAVEFRONT FUNCTION

I 1800 °



— 26
— 46
— 66
— 86

RMS 275.4231 P-V 2648.377



2880 °
2160 °
1440 °
720 °

0 (mm)

20

40

60

80

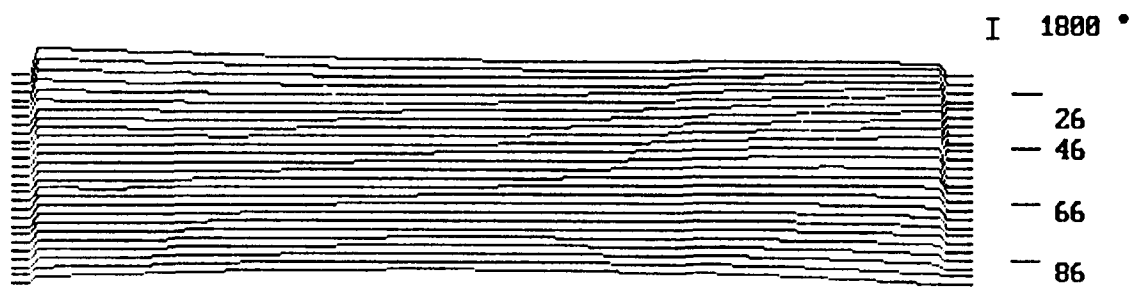
0 °

TRACE # 75

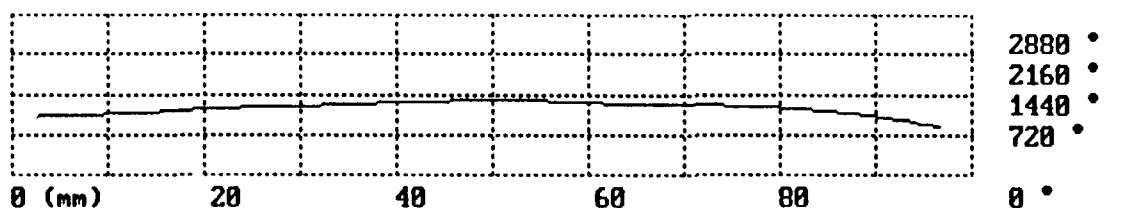
RMS 23.08077

P-V 349.8361

CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / WAVEFRONT FUNCTION



RMS 275.4231 P-V 2648.377



0 (mm)

20

40

60

80

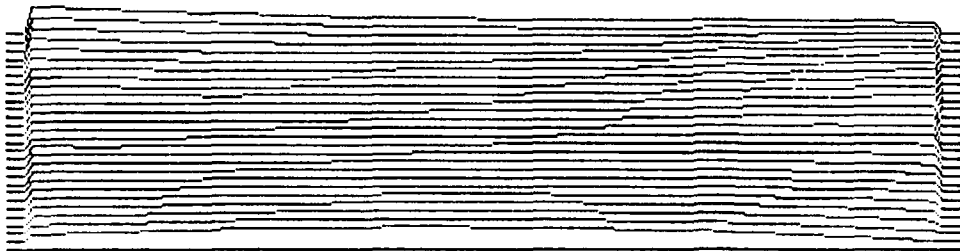
TRACE # 80

RMS 30.37861

P-V 460.5441

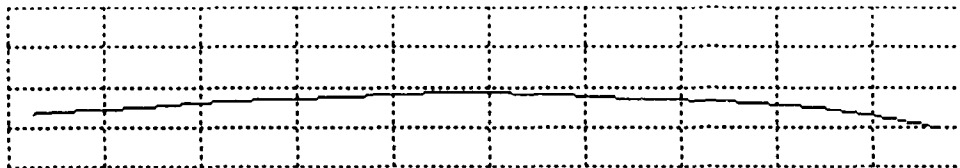
CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / WAVEFRONT FUNCTION

I 1800 °



— 26
— 46
— 66
— 86

RMS 275.4231 P-V 2648.377



2880 °
2160 °
1440 °
720 °

Ø (mm)

20

40

60

80

Ø °

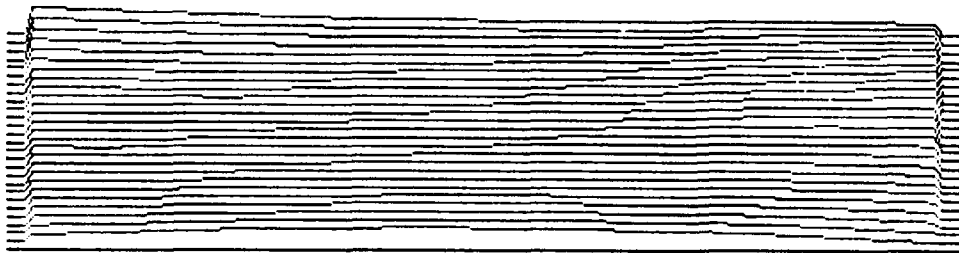
TRACE # 85

RMS 40.37565

P-V 616.2419

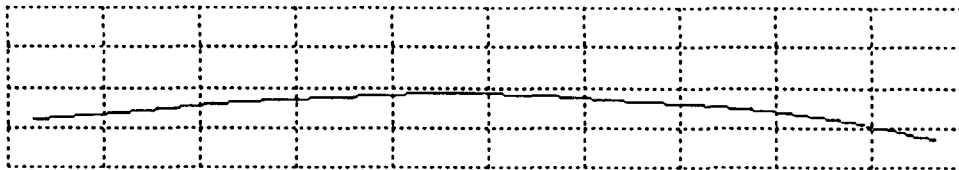
CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / WAVEFRONT FUNCTION

I 1800 °



— 26
— 46
— 66
— 86

RMS 275.4231 P-V 2648.377



2880 °
2160 °
1440 °
720 °
0 °

Ø (mm)

20

40

60

80

0 °

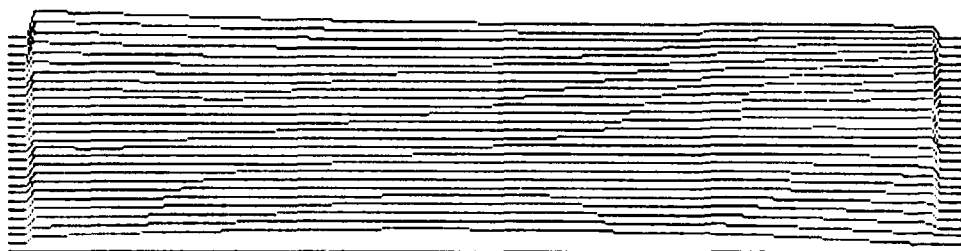
TRACE # 90

RMS 53.98688

P-V 837.9254

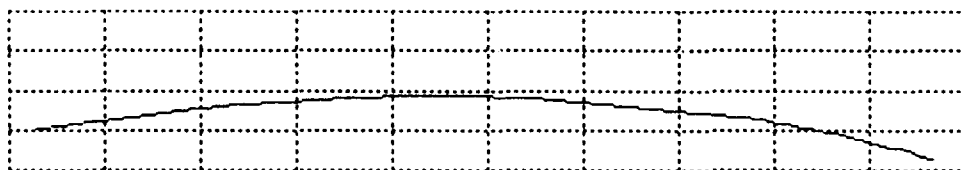
CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / WAVEFRONT FUNCTION

I 1800 °



— 26
— 46
— 66
— 86

RMS 275.4231 P-V 2648.377



2880 °
2160 °
1440 °
720 °

0 (mm)

20

40

60

80

0 °

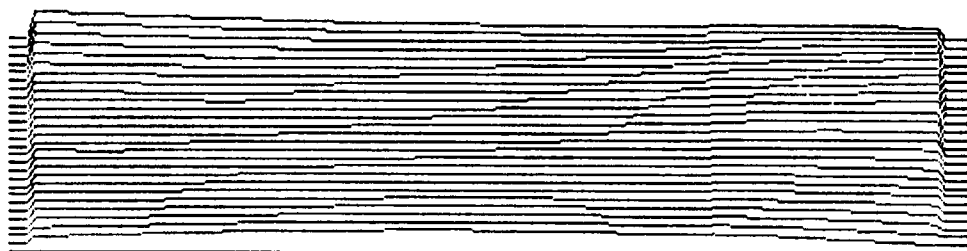
TRACE # 95

RMS 71.74483

P-V 1138.347

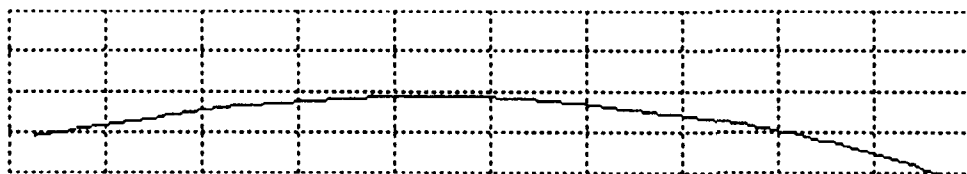
CYLINDRICAL MIRROR : MULTITRACE MEASUREMENT / WAVEFRONT FUNCTION

I 1800 °



— 26
— 46
— 66
— 86

RMS 275.4231 P-V 2648.377



2880 °
2160 °
1440 °
720 °

θ (mm)

20

40

60

80

0 °

TRACE # 98

RMS 84.04984

P-V 1357.277